

Live Performance of Male Broilers Subjected to Constant or Increasing Air Velocities at Moderate Temperatures with a High Dew Point¹

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ABSTRACT This study examined the effects of varying air velocities vs. a constant air velocity with a cyclic temperature curve of 25-30-25°C and a dew point of 23°C on broilers from 28 to 49 d of age. Four replicate trials were conducted. In each trial, 742 male broilers were randomly allocated to 6 floor pens or 2 air velocity tunnels, with each tunnel consisting of 4 pens. Bird density, feeder, and waterer space were similar across all pens (53 birds/pen; 0.07 m²/bird). The treatments were control (still air), constant air velocity of 120 m/min, and increasing air velocity (90 m/min from 28 to 35 d, 120 m/min from 36 to 42 d, and 180 m/min from 43 to 49 d). Birds grown in

a still air environment gained less weight, consumed less feed, and converted feed less efficiently between 28 and 49 d than birds subjected to moving air (constant or increasing). Growth responses between the air velocity treatments were similar from 28 to 35 and 36 to 42 d of age. Increasing air velocity to 180 m/min improved ($P \leq 0.02$) the growth rate of broilers from 43 to 49 d of age over birds receiving an air velocity of 120 m/min, but the incidence of mortality was not affected. These results provide evidence that increasing air velocity from 120 to 180 m/min is beneficial to broilers weighing 2.5 kg or greater when exposed to moderate temperatures.

(Key words: broiler, air velocity, dew point, moderate temperature)

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INTRODUCTION

Poultry housing has dramatically improved over the last couple of decades resulting in improved broiler performance (Lacy and Czarick, 1992). Metabolic heat production increases as a bird accumulates body mass (Lott et al., 1998). Application of air velocity during grow out facilitates heat removal by causing a proportional shift from latent to sensible heat loss (Simmons et al., 1997). Sensible heat loss is the transfer of heat from an animal by passing of air over the animal, whereas latent heat loss (heat of evaporation) is heat associated with the phase change of water (i.e., bird panting to remove heat). As body mass increases, the surface area per unit of BW decreases; therefore, increasing air velocity augments heat dissipation from the surface of the bird with a concomitant decrease in heat loss from latent heat.

Determining the air velocity needs for birds at different BW is paramount in optimizing growth rate and minimizing the occurrence of late mortality. Simmons et al. (2003) evaluated growth responses of male broilers subjected to constant air velocities of 120 or 180 m/min from 21 to 49 d under a diurnal temperature cycle (25-30-25°C). BW gain and nutrient utilization from 43 to 49 d of age were improved as the air velocity was increased from 120 to 180 m/min. Providing an air velocity of 120 m/min was adequate from 21 to 42 d of age. However, the air velocity needs of a broiler may be lower than 120 m/min at 3 to 4 wk of age or BW less than 2.0 kg depending on ambient temperature. Under moderate temperatures, maximum BW gain occurs from 28 to 35 d (1.5 to 2.2 kg), and growth rate is optimized at earlier ages or lower BW when birds are exposed to high ambient temperatures (Simmons et al., 2003; Dozier et al., 2005).

Providing an air velocity of 180 m/min from 21 to 49 d of age (1.5 to 3.0 kg in BW) would potentially remove excess sensible heat, thus adversely affecting feed conversion. Additionally, maintaining constant high air velocities would increase electrical cost. Increasing air velocity as the bird gains in body mass would be more appropriate than using a constant air velocity. This study compared a constant air velocity vs. a variable air velocity program from 28 to 49 d of age.

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TABLE 1. Actual temperature (25-30-25°C¹) and air velocity (m/min) provided to male broilers from 28 to 49 d

Item	Maximum	Minimum	Average	SD
Temperature (°C)	30.0	25.0	27.5	1.8
Constant air velocity ²				
28 to 35 d	125	114	119	2
36 to 42 d	123	114	118	1
43 to 49 d	125	114	119	2
Increasing air velocity ³				
28 to 35 d	96	85	90	2
36 to 42 d	123	114	119	1
43 to 49 d	189	174	180	3

¹Room temperature.²Air velocity of 120 m/min was provided to broilers from 21 to 49 d.³Air velocity was provided to broilers at 90 m/min from 28 to 35 d of age, 120 from 36 to 42 d, and 180 m/min from 43 to 49 d of age.

MATERIALS AND METHODS

General Procedures

Four replicate trials were conducted from 28 to 49 d of age and used 2,968 male broilers (742 birds/trial). Male broiler chicks were purchased from a commercial hatchery and placed in a common rearing facility until 28 d of age. At d 28, birds were weighed and allocated to 14 groups with BW being equated at the start of experimentation. In each trial, birds were randomly distributed into either of 2 wind tunnels (4 pens/wind tunnel) or 6 floor pens of a closed-sided environmental-controlled facility (53 birds/pen; 700 cm²). The wind tunnel pens and the floor pens were identical in respect to floor space, temperature, lighting (intensity and dura-

tion), and feeder and waterer space per bird. Each pen (wind tunnel pens and floor pens) was equipped with a tube feeder and a trough waterer. Birds were provided feed and water ad libitum. Corn-soybean meal based diets were formulated to meet or exceed NRC (1994) nutrient recommendations and were provided as whole pellets.

Treatments

Three treatments were implemented, and each was represented by 4 replications. The experimental treatments consisted of a control (floor pens and still air), wind tunnel with a constant air velocity of 120 m/min, and wind tunnel having variable air velocity (90 m/min from 28 to 35 d; 120 m/min from 36 to 42 d, and 180 m/min from 43 to 49 d). Incidental air velocity over the control group was less than 15 m/min. Temperature within the facility was a diurnal cycle of 25-30-25°C over 24 h with a constant dewpoint of 23°C. The temperature cycle followed a sine wave curve during a 24-h interval. A second order polynomial equation was developed by using the amount of voltage from a DC generator attached to the shaft of the fan in the wind tunnel compared with the air velocity in the wind tunnel measured from an anemometer array as described by Simmons et al. (1998). The second order polynomial equation was used to calculate the air velocity in the wind tunnels from the voltage derived from the DC generator.

Measurements

Pen and feed weights were weighed on 28, 35, 42, and 49 d of age. Growth rate, feed consumption, and feed

TABLE 2. Live performance responses of male broilers subjected to various air velocities under moderate cyclic temperatures from 28 to 35 d of age¹

Treatments	BW (g)	BW gain (g)	FC ² (g)	FG ³	Mortality (%)
Control (still air) ⁴	1,944 ^b	549 ^b	1,039 ^b	1.90	2.3
Constant ⁵	2,041 ^a	644 ^a	1,155 ^a	1.79	1.9
Variable ⁶	2,025 ^a	628 ^a	1,123 ^a	1.79	1.5
SEM	21	18	16	0.04	0.9
Planned contrasts ⁷	Probabilities				
Control vs. air velocity	0.013	0.008	0.002	0.053	0.630
Constant vs. increasing	0.623	0.545	0.198	0.964	0.770

^{a,b}Means not followed by a common letter differ significantly based on least significant difference comparisons at $P \leq 0.05$.¹Values are least-squares means of four trials with the air velocity treatments having 848 birds and the floor pen (control) having 1,272 birds at the initiation of experimentation.²FC = feed consumption per bird.³FG = feed conversion ratio corrected for mortality.⁴Broilers not receiving air velocity treatment.⁵Broilers subjected to an air velocity of 120 m/min from 28 to 49 d of age.⁶Broilers subjected to an air velocity of 90 m/min from 28 to 35 d of age, 120 from 36 to 42 d of age, and 180 m/min from 43 to 49 d of age.⁷Planned orthogonal contrasts.

TABLE 3. Live performance responses of male broilers subjected to various air velocities under moderate cyclic temperatures from 36 to 42 d of age¹

Treatments	BW (g)	BW gain (g)	FC ² (g)	FG ³	Mortality (%)
Control (still air) ⁴	2,454 ^b	511 ^b	1,095 ^b	2.15 ^a	3.9 ^a
Constant ⁵	2,677 ^a	637 ^a	1,250 ^a	1.97 ^b	2.2 ^b
Variable ⁶	2,668 ^a	643 ^a	1,244 ^a	1.94 ^b	1.7 ^b
SEM	23	6	14	0.03	0.4
Planned contrasts ⁷	Probabilities				
Control vs. air velocity	0.0002	0.0001	0.0001	0.002	0.006
Constant vs. increasing	0.781	0.491	0.778	0.569	0.393

^{a,b}Means not followed by a common letter differ significantly based on least significant difference comparisons at $P \leq 0.05$.

¹Values are least-squares means of four trials with the air velocity treatments having 848 birds and the floor pen (control) having 1,272 birds at the initiation of experimentation.

²FC = feed consumption per bird.

³FG = feed conversion ratio corrected for mortality.

⁴Broilers not receiving air velocity treatment.

⁵Broilers subjected to an air velocity of 120 m/min from 28 to 49 d of age.

⁶Broilers subjected to an air velocity of 90 m/min from 28 to 35 d of age, 120 from 36 to 42 d of age, and 180 m/min from 43 to 49 d of age.

⁷Planned orthogonal contrasts.

conversion were calculated at weekly intervals. The incidence of mortality was recorded daily. In addition, air velocity and ambient temperature were measured at 30-min intervals throughout each trial. Sensors³ were used to measure temperature and moisture. A sensor³ was located at the inlet end for each tunnel and the middle of the floor pens.

Statistics

Data were evaluated by the GLM procedure of SAS (2004) involving a one-way treatment structure in a randomized complete block design. Each of the 4 trials over time represented a block. The experimental unit was the

average value of the 4 pens in a tunnel and 6 floor pens, respectively, because air velocity treatments were fixed effects. Treatment means were separated using orthogonal contrasts. All statements of significance were based upon $P \leq 0.05$ unless otherwise noted.

RESULTS AND DISCUSSION

The actual average temperature and air velocities were in close agreement to their target set points (Table 1). Broilers subjected to air velocity grew faster ($P = 0.008$) and consumed more feed ($P = 0.002$) than the control group (Table 2). Nutrient utilization was improved at $P = 0.053$, but the incidence of mortality was

TABLE 4. Live performance responses of male broilers subjected to various air velocities under moderate cyclic temperatures from 43 to 49 d of age¹

Treatments	BW (g)	BW gain (g)	FC ² (g)	FG ³	Mortality (%)
Control (still air) ⁴	2,832 ^b	378 ^a	1,086 ^b	2.87 ^a	4.0
Constant ⁵	3,170 ^a	493 ^b	1,331 ^a	2.71 ^{ab}	2.6
Variable ⁶	3,227 ^a	559 ^c	1,373 ^a	2.48 ^b	2.8
SEM	27	12	42	0.10	0.5
Planned contrasts ⁷	Probabilities				
Control vs. air velocity	0.0001	0.0001	0.002	0.078	0.083
Constant vs. increasing	0.182	0.008	0.506	0.165	0.759

^{a,b}Means not followed by a common letter differ significantly based on least significant difference comparisons at $P \leq 0.05$.

¹Values are least squares means of four trials with the air velocity treatments having 848 birds and the floor pen (control) having 1,272 birds at the initiation of experimentation.

²FC = feed consumption per bird.

³FG = feed conversion ratio corrected for mortality.

⁴Broilers not receiving air velocity treatment.

⁵Broilers subjected to an air velocity of 120 m/min from 28 to 49 d of age.

⁶Broilers subjected to an air velocity of 90 m/min from 28 to 35 d of age, 120 from 36 to 42 d of age, and 180 m/min from 43 to 49 d of age.

⁷Planned orthogonal contrasts.

similar among the treatments. Increasing air velocity from 90 to 120 m/min did not alter growth responses of male broilers from 28 to 35 d of age. Because both wind tunnels were set at 120 m/min during 36 to 42 d of age, no treatment differences were apparent (Table 3). Broilers receiving any air velocity had improved BW gain ($P = 0.0001$), feed consumption ($P = 0.0001$), feed conversion ($P = 0.002$), and incidence of mortality ($P = 0.006$) compared with broilers grown in still air.

Air velocity altered growth response of male broilers from 43 to 49 d of age (Table 4). Growth rate was increased ($P = 0.008$) as air velocity increased from 120 to 180 m/min, but feed conversion, feed consumption, and the occurrence of mortality were not affected. Broilers receiving any air velocity had significant ($P \leq 0.002$) advantages in BW gain and feed consumption compared with broilers grown in still air.

In the current study, increasing air velocity from 90 to 120 m/min did not affect growth performance from 28 to 35 d of age (1.5 to 2.2 kg). Increasing air velocity to 180 m/min during this period does not provide advantages in growth (Simmons et al., 2003) but may adversely affect feed conversion when broilers experience moderate temperatures. Dozier et al. (2005) reported that increasing air velocity from 120 to 180 m/min improved growth of broilers during 29 to 35 d (2.0 kg) under high cyclic temperatures (25-35-25°C).

Simmons et al. (2003) reported a 17% improvement in BW gain as air velocity was increased from 120 to 180 m/min from 43 to 49 d of age with male broilers exposed to moderate temperatures (25-30-25°C). In the present study, growth rate was improved by 13% from 43 to 49 d of age as air velocity was increased. The benefit of increasing air velocity during the final week of experimentation may be related to sensible heat loss. As body mass increases, the surface area per unit of BW decreases making sensible heat removal more difficult. Application of air velocity to the body surface causes a proportional shift in heat loss from latent to sensible

(Mitchell et al., 1985; Simmons et al., 1997). Latent heat removal (panting) expends more energy than sensible heat loss reducing the amount of productive energy available for growth.

In conclusion, increasing air velocity from 120 to 180 m/min did improve BW gain of broilers from 2.6 to 3.2 kg. Broilers (1.5 to 2.2 kg) did not respond to increasing air velocity from 90 to 120 m/min; however, heat buildup down the house may occur when 90 m/min is used at this weight range. Application of high air velocities (180 m/min) may adversely affect feed conversion of broilers from 1.5 to 2.5 kg when exposed to moderate temperatures.

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